THE SCOTTISH OFFICE

Strategy for Agricultural, Biological and Related Research

1999-2003

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CONTENTS

1 EXECUTIVE SUMMARY

1.1 This Strategy for The Scottish Office Agriculture, Environment and Fisheries Department's research programme in agricultural, biological and related sciences has been drawn up following an extensive consultation and review process. This has involved a wide range of stakeholders, namely research organisations, Departmental policy divisions and related sponsored bodies, end-user sectors, and other funders. The purpose of the review was to develop a Strategy which builds on existing strengths, takes advantages of new scientific opportunities, addresses modern end-user needs with particular reference to Scotland, and identifies priorities accordingly.

1.2 The result is a document which carries forward and develops the Department's research programme into the period when the Scottish Executive of the new Scottish Parliament will take over the existing functions of SOAEFD. As such the implementation of the Strategy, including any consequential decisions flowing from it, will be a matter for the new Scottish Executive.

1.3 SOAEFD funds a major research programme in agricultural, biological and related science as a significant part of the UK science base in this area. The programme is conducted primarily through the five Scottish Agricultural and Biological Research Institutes, which form part of a UK network with research institutes funded by Research Councils, with important components also being provided by the Scottish Agricultural College and the Royal Botanic Garden Edinburgh. This strategic research programme is widely regarded as being of national, and in many areas international, excellence, and while much of it relates specifically to Scottish circumstances, the programme is also of much wider relevance and significance.

1.4 As one of a series of periodic reviews of its programme, the Department conducted a review of its research strategy during 1998-99. The Department is grateful to all who participated in the review. The consultation exercise revealed a wide measure of support for the strategic emphasis of the research programme; a need for greater emphasis on the relevance of the programme to its end-users and on improved knowledge transfer to those end-users; the potential for further institute collaboration; and the need for a greater degree of competition in the Department's funding system.

1.5 As a result the Department has formulated a new statement of its aim and objectives for the research programme. The Department's aim is:

> **To support a high quality science base in agricultural, biological and related sciences, and to fund research of strategic relevance to, and in support of, policy areas of The Scottish Office and the related end-user communities in Scotland and beyond.**

1.6 Within that aim the five key objectives for the period 1999-2003, and the main actions which the Department intends to take under each of those objectives, are:

Objective 1: To support and maintain, as part of the UK science base, a strategic research capability in key areas of agricultural, biological, and related environmental, physical and social science, building on existing strengths and taking account of new opportunities and changing end-user needs.

- Maintain the primarily strategic nature of the research programme, with both a component at the underpinning basic research level and an increase in work at the more applied end of the spectrum in support of policy or where this does not impinge on work properly funded by industry;
- A further move towards ensuring that there is critical mass and scientific depth of effort in the strategically important areas of the programme;
- A refocusing and rationalising of components of the programme, to create the ability for increased funding in areas of continuing and new priority, such as enhanced use of genomics, socio-economics, and systems research.

Objective 2: To widen further the range of end-uses of the Department's research programme and to ensure the programme is relevant to the short, medium and long-term needs of its end-use sectors and Scottish Office policies for those sectors.

- Widen the range of end-use sectors for the biological and related research programme to give enhanced emphasis to sustainable agriculture, the environment, nutrition and human health, food and bioindustries, and rural development;
- Ensure greater involvement of policy makers and end-use sectors in the specification of the programme;
- Include policy and end-user interests in the five-yearly peer review process of the sponsored bodies to enhance the assessment of the relevance of the work.

Objective 3: To enhance the quality and effectiveness of the research programme through improved focus and direction, co-ordination, collaboration and competition.

- Increase the Department's co-ordination of grant-in-aid programmes at the sponsored bodies;
- Increase collaboration between sponsored bodies, other institutions and universities through joint funding initiatives and co-ordination with other funders of biological and related research;
- Introduce internal competition between the sponsored bodies by linking the main core funding to the outcome of a five-yearly peer review process, and by opening up an element of grant-in-aid to competitive bidding.

Objective 4: To foster knowledge and technology transfer from the science base to the end-users.

- Give greater emphasis to knowledge transfer and application in the specification for all research projects;
- Review and develop the existing systems of knowledge transfer and IPR policy to ensure both knowledge transfer and commercialisation are promoted efficiently and effectively;
- Work closely with SOEID and Scottish Enterprise in their research innovation and commercialisation strategy.

Objective 5: To improve information dissemination from, and public awareness of, the Department's research programme and its outputs.

- Create and develop a Website for the Department's research programme, and develop a series of publications and newsletters;
- Hold a series of workshops to promote the outcome of Departmentally-funded work, particularly the co-ordinated programmes;
- Ensure proper publicity is given to individual research successes funded through the Department's programme.

1.7 The Department will take forward this Strategy in consultation with its main sponsored bodies, with end-users of the research, and with other funders of cognate research both in Scotland and in the UK more generally. It will publish an Annual Report detailing progress made towards achieving the objectives.

1.8 Requests for further information about the Department's research programme, and any other enquiries, should be directed to the Research, Education and Advisory Services Division of SOAEFD at Pentland House, Robb's Loan, Edinburgh, EH14 1TY.

2 CONTEXT AND STRATEGY REVIEW

Context

2.1 The Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD), funds a range of agricultural and related biological and environmental science from basic and strategic research through to more applied work. It does so in support of the Department's overall aim which is:

> **"To help the people of Scotland to secure a life of quality and prosperity through sensitive stewardship and sustainable development of the natural resources of Scotland."**

2.2 The research programme in this area is predominantly supported through seven sponsored bodies to whom the Department provides grant-in-aid funding for core programmes of research. These are the five Scottish Agricultural and Biological Research Institutes (SABRIs), the Scottish Agricultural College (SAC), and the Royal Botanic Garden Edinburgh (RBGE). Each body has a remit, agreed with the Department, which complements the range of work conducted at the others. The remits are set out at Annex A. These sponsored bodies have in the last 3 years been subject to in-depth prior option reviews which confirmed the continued need for the establishments and the types of research carried out in them.

2.3 In commissioning research across the spectrum from basic and strategic research to more specific applied and policy-related research, the Department occupies a unique position in having a role partly of a Research Council, funding at its seven sponsored research bodies a significant part of the UK science base in agricultural, biological and related research, and partly of a Departmental 'customer' for research. This enables it to adopt a holistic approach to research funding, through the integration of research not only across the research spectrum from basic to applied but also across disciplines and institutes.

2.4 The Department therefore shares with the UK Research Councils (primarily BBSRC and NERC, whose own research institutes are of similar character to the SABRIs) the funding of the UK science base in this area. The research programme which this represents (some £50m in total) is accordingly of national and indeed international significance: recent citation analyses demonstrate the major Scottish strengths in plant, animal and related sciences. And within these disciplines the institutes have made considerable advances in the areas of animal and plant

health, livestock and crop productivity, environmentally sustainable farming systems, food quality and nutrition, understanding of land use and the environment, and the uses of biotechnology.

2.5 SOAEFD also supports research funded through Scottish Natural Heritage (SNH), the Scottish Environment Protection Agency (SEPA), the Fisheries Research Services (FRS), and the Scottish Agricultural Science Agency (SASA), as well as a policy-led environment and social research programme managed directly by the Department. The Department also has an interest in the research programme of the Forestry Commission. The work of these programmes, a brief account of which is given at Annex B, is not covered by this Strategy, but attention is given to the opportunities for development of collaborative links with them. Elsewhere in The Scottish Office, there are major research programmes funded through the Scottish Higher Education Funding Council (SHEFC) and the Chief Scientist's Office in The Scottish Office Department of Health.

2.6 The development of this Strategy took place against the backdrop of devolution and this document seeks to carry forward the Department's research programme into the period when the Scottish Executive will take over the existing functions of SOAEFD. The new Strategy is based on the spending plans announced by the Government in the summer of 1998 following their Comprehensive Spending Review. These plans may be revisited by the new Scottish Executive.

General Principles

2.7 A number of general principles have underpinned the thinking and development of the Strategy:

- The importance of science as a driver of wealth creation through the development of technical progress, the delivery of innovation, and the support of the knowledge economy;
- The importance of science in delivering improvements in quality of life through, for example, enhanced health and well-being and through increased understanding and enjoyment of the environment;
- The importance of the strategic focus of the mission driven approach of research institutes which ensures that the underpinning science is developed not only for immediate issues but those which are likely to emerge in the next 10 to 15 years;

- The importance of continuing to be part of the UK science base, ensuring that close links are maintained with Research Councils and other funders, and that the strategic research programme complements those of other funders;
- The need for the research programme to be aligned to meet end-user priorities, taking account of the Foresight exercise, and to foster partnership between the science base, industry and Government;
- The continuing priority accordingly given to science and innovation reflected in the funding made available to the Department's programme as a result of the Government's 1997-98 Comprehensive Spending Review.

The Strategy Review Process and Findings

2.8 The Department's review of its Research Strategy was launched with the issue of a consultation document to over 200 interested parties. The aims of the review were:

- To review the existing strengths of the programme and to identify new opportunities for the science base;
- To assess the modern needs of end-users of the science whether within or outwith Government;
- To consider how to build links between the Department's sponsored bodies and the university sector;
- To ensure that the outputs of the research programme are effectively reaching those best placed to build on them;
- To consider the quality of the existing programme and how this is measured;
- To inform a wider audience about the programme and the work of the sponsored bodies.

2.9 In addition to the written consultation exercise more than 30 discussion meetings were held with a range of funders of science, Departmental sponsored bodies, policy divisions across The Scottish Office, a range of industry interests and other end-users of the research. The Department also conducted an analysis of the strengths, weaknesses and opportunities of the science content of the research programme, convening a number of panels involving external scientists. The

Department has also drawn on the outcome of the recent intensive programme of peer review of its sponsored bodies, under which they have been examined by Visiting Groups of external scientists. The whole review process was overseen by a Steering Group which included representatives of two of the other major funders of cognate research (MAFF and BBSRC), policy divisions in SOAEFD and SOEID, and an external scientist, Dr C A Gilligan from the University of Cambridge.

2.10 The key messages to emerge from the wide range of consultations were:

- There was a widespread lack of awareness of the research programme and of its relevance to policy and to end-users coupled with a misconception that the programme was geared primarily towards improving agricultural production;
- Whilst there was strong support for the excellence and depth of the majority of the programme, its role in the Scottish and UK science base and its strategic nature, there was criticism of some areas of science;
- There was a call for better collaboration between the sponsored bodies and particularly between them and universities, and for increased internal competition for the research funds which the sponsored bodies receive from the Department;
- There was a call for improved knowledge transfer from the scientific research programme to end-users;
- There was a call for the Department to give a greater lead both in terms of the scientific direction and of policy, and to raise its profile as a significant funder of research and the science base.

Conclusion

2.11 In the light of the review the Department has formulated a new Strategy for the next 4 years. SOAEFD will continue to fund a strategic research base which contributes to part of the UK effort and will ensure that the programme is relevant to a broad range of end-users. The Department will encourage and assist the sponsored bodies to produce science of the highest calibre, and at the cutting edge internationally, as well as strengthening links to end-users, fostering knowledge and technology transfer, and raising the profile of the Department.

2.12 To do this the Department has developed a new aim for its research programme, together with 5 high level objectives:

Aim

> **"To support a high quality science base in agricultural, biological and related sciences, and to fund research of strategic relevance to, and in support of, policy areas of The Scottish Office and the related end-user communities in Scotland and beyond."**

Objectives

1. To support and maintain, as part of the UK science base, a strategic research capability in key areas of agricultural, biological and related environmental, physical and social sciences, building on existing strengths and taking account of new scientific opportunities and changing end-user needs.

2. To widen further the range of end-uses of the Department's research programme and to ensure the research programme is relevant to the short, medium and longterm needs of its end-use sectors and Scottish Office policies for those end-use sectors.

3. To enhance the quality and effectiveness of the research programme through improved focus and direction, co-ordination, collaboration and competition.

4. To foster knowledge and technology transfer from the science base to the end-users.

5. To improve information dissemination from, and public awareness of, the research programme and its outputs.

2.13 These objectives, and the Department's plans for achieving them, are described in more detail in the following Chapters. The Department will monitor its progress in achieving the objectives and will set out that progress in Annual Reports.

3 OBJECTIVE 1 – STRATEGIC SCIENCE BASE

> **"To support and maintain, as part of the UK science base, a strategic research capability in key areas of agricultural, biological, and related environmental, physical and social sciences, building on existing strengths and taking account of new opportunities and changing end-user needs."**

3.1 As explained in Chapter 2, SOAEFD research currently forms a significant part of the UK strategic science base in agricultural and related biological sciences. It encompasses certain critical areas of basic science but is centred primarily on strategic scientific research which is medium to long-term in nature while being carried out with ultimate application in mind. This strategic science capability forms the base on which more applied and short-term scientific research can be conducted as and when it is required. Co-ordination with the programmes of other funders, principally MAFF, BBSRC and NERC, is maintained through bilateral and multi-lateral liaison mechanisms designed to ensure the respective programmes of these different funders complement one another.

3.2 SOAEFD takes the UK lead for soil science, sheep research, dairy research, and potato, spring barley and soft fruit research. There are particular strengths in soil science, land-use research and waste management, vegetation dynamics, plant genetics, crop breeding protection and biotechnology, animal nutrition, reproduction and development, animal health and welfare and biomathematics and statistics.

3.3 As confirmed by recent Visiting Groups the output of the Department's strategic research programme is of high, and in many areas international, quality reflecting the sustained investment by the Department in key areas of the science base over many years and due also to the performance of the research institutes and other sponsored bodies themselves. SOAEFD will continue to support this part of the UK science base and, following strong endorsement during the consultation exercise, is committed to continuing the emphasis on the strategic underpinning nature of its research programme.

Science Appraisal

3.4 As part of the Strategy Review a scientific appraisal of the current SOAEFD programme of research was undertaken to inform the process of developing the future strategy. This was carried out by panels of independent external advisers,

drawn from a variety of backgrounds and experience. This procedure identified many areas of excellence and emerging scientific opportunities. The Department intends to maintain and build on these internationally competitive strengths, and ensure that they continue to be relevant to strategic end-use needs. The principle of developing emerging opportunities and requirements for strategic science will also be followed. Other parts of the programme were identified as "mature" or declining in scientific or policy importance. Areas of science which do not appear to have critical mass, which are unlikely to yield science of at least national significance, or areas of the programme which are no longer strategically relevant, will therefore be evaluated to identify options to decrease or refocus effort. The Department will discuss the programme in more detail with the sponsored bodies with a view to switching out of these areas and building on strengths and opportunities.

3.5 The results of the strategy review consultation, scientific appraisal and the most recent Visiting Group peer review exercise have been used to inform the formulation of the future direction for each of five scientific domains over the next 4 years. These are described in the summary paragraphs below with a fuller discussion in Annex C. While the review processes have identified areas for further consideration, the details and exact shape of the future programme will be determined in consultation with the relevant sponsored bodies, along with policy, industrial and academic end-user interests.

3.6 **Soil and Environmental Sciences:** The research within this domain is generally nationally competitive with areas of international strength particularly in soil microbiology, soil physics and grazing ecology. The future strategy will focus the soil-related research to emphasise the soil/root interface, soil protection and scaling up from the small scale to the ecosystem scale and beyond to the catchment. Research on waste and pollutants has been a major component of the programme but will now be considered for some rationalisation. End-user utility and opportunities for co-funding and collaboration will drive the programme of water research which has the scope to be internationally significant. The Department's land management programme will be reviewed to add value to studies of extensive upland grasslands and grazing ecology by a more integrated approach. An emphasis on co-ordinating the research on natural heritage and biodiversity will increase the utility of this important area of study.

3.7 **Plant Science:** A major strength of the plant science programme is the integration of work on germplasm collections with both conventional crop-specific breeding and modern molecular approaches including genomics. Research on the diversity and evolutionary relationships of plants combined with underpinning

work on systematics and taxonomy is highly regarded. Future priorities will focus on the use of genomics and functional genomics research, in particular within the cereals programme and to a lesser extent in the potato and pathology programmes. In addition, there will be increased emphasis on work undertaken at the system and crop levels to include research on populations, communities, crops and ecosystems. The work will also be integrated more with studies on the nutritional content and product quality of plant-based foods and with the potential application of non-food crops in mind. Within the plant science programme as a whole, greater care will be taken to ensure that the commissioned work aligns well with the needs of end-users and the future programme will have to meet current and future end-user needs.

3.8 **Animal Science:** Research in the area of animal science funded by SOAEFD is generally seen to be of high quality, much of it of international standing, having particular strengths in cell biology and nutrient metabolism, appetite control and diet selection, and animal physiology. Future priorities for the animal science programme will centre on maintaining effort in areas of current strength including studies on fundamental biology relevant to human nutrition, cellular and metabolic control mechanisms and studies of whole animal physiology particularly in commercially important species. There is considerable opportunity for advancing knowledge about complex physiological and metabolic systems by adopting information and approaches emerging from human, animal and microbial genome programmes. The animal science programme will also be more fully integrated with research on primary product quality, particularly in the area of muscle biology, and other work underpinning the Scottish food industry. A number of areas of research will, however, be scrutinised to refocus or rationalise work which is no longer of high strategic priority.

3.9 **Animal Health and Welfare:** The SOAEFD-funded programme of research in Animal Health and Welfare is highly regarded both nationally and internationally. There are recognised scientific strengths in sheep immunology, immunopathology of parasitic and viral diseases, parasitology and animal behaviour. Particular skills in translating scientific discovery into practical application in the field of animal welfare are also well regarded. SOAEFD will build on existing strengths within these disciplines to underpin highly focused research on specific health and welfare problems of domesticated animals. The role of veterinary surveillance/field work will be developed and juxtaposed with the laboratory-based research programmes. Within the research programmes, there will be an emphasis on the exploitation of information generated by genomics or proteomics research to enhance understanding of animal health problems. This

will include studies of host-pathogen interactions, control of pathological processes, including the genetic basis of disease, and regulation of immune function.

3.10 **Socio-economics and Land Use:** SOAEFD funds a considerable programme of research related to land use issues in Scotland although comparatively little emphasis has hitherto been placed on the application of social science techniques to the research. Much of this work is potentially valuable to policy groups within SOAEFD and more widely, and we recognise that there is a need to broaden land use research and to strengthen and build on social science approaches to it. Therefore the Department intends to build up the social science component of land use research and to encourage its further use. The land use research programme at present lacks focus and cohesion and it is intended that these aspects will also be addressed in reviewing and developing the programme. The potential for enhancing other areas of the science programme by addition of economics and social science approaches will also be evaluated.

Generic Opportunities

3.11 During the consideration and review of the SOAEFD programme it became clear that across the domains there are important scientific opportunities, which need to become more pervasive throughout the programme as a whole or where development of the science and its application within the programme will stimulate significant progress in scientific knowledge, understanding and its application. The Department believes these opportunities are crucial to its future programme strategy and intends to encourage the adoption of these approaches where relevant within the programme. The three main opportunities identified are described in the following paragraphs.

3.12 **Genomics:** This rapidly developing area of biological science provides opportunities of different types for the Department's plant and crop science programme and for its animal science programme. In plant and crop science, and in microbial systems research, there is a need for SOAEFD-funded organisations to be actively involved in generating and analysing high-throughput gene identification and analysis data ("Functional Genomics"). This approach will build on the existing platform of plant genomics research and molecular marker technology. Access to robotic systems, microarray technology and improved methods of bioinformatics analysis will be essential if the programme is to maintain a competitive edge into the next century. This will build on the strengths already identified in our sponsored bodies. Where adequate provision is not already available, the Department will be prepared to consider joint funding such

initiatives. It is likely that a co-ordinated approach, the development of specialised, regional centres of excellence and the sharing of joint facilities within Scotland will be required to justify such expenditure.

3.13 In animal science, the sponsored bodies are very well placed to make further use of the considerable information emanating from the extensive programmes of human, animal and microbial genomics funded by other sponsors. This information will enable new understanding to be brought to the study of complex questions in animal biology at the cell, tissue and organism level. It is essential that these opportunities are sought and that effective interaction between those generating data from genomics research programmes and those with the ability to set this new understanding in an appropriate biological context, both at organism and population level, is encouraged. The Department will be looking to introduce such refocusing of the programme both through the redirection of grant-in-aid funding and through competitive contracts.

3.14 **Socio-economics:** Currently socio-economics research forms only a small component of the SOAEFD programme. With the changes in European, UK and domestic policies for the rural sector it is becoming increasingly important to analyse and understand agriculture, rural development and land use more generally within a social context. The value of applying social science techniques and economic analysis in relation to rural development studies is widely acknowledged, and the Department recognises that there is a need to develop the use of this type of research and to integrate it within the research programme more generally. This is particularly so in relation to those parts of the programme relevant to agriculture but also in relation to other aspects, for example food production and consumption, and conservation and the environment. Such studies are essential if effective and sustainable rural economies are to be maintained. Social science and economics research can complement agricultural, biological and environmental research, and the Department intends to increase that part of the programme devoted to this area

3.15 **Systems Research:** A unique feature of SOAEFD's method of funding research is its ability to support truly multidisciplinary research activities within and across its research institutes and establishments. The Department already funds studies of agricultural systems which integrate environmental, animal, plant, soil and microbial research. There is now an opportunity to increase this component of the programme in order to provide strategic support to the sustainability of Scottish agriculture post-CAP reform. Particular attention will be given to the development of ecologically and economically sustainable agricultural systems,

protection of the environment and to the integration of biological processes at a range of scales from individual plants and animals to populations, communities and ecosystems.

3.16 The programme will provide an experimental and theoretical framework to analyse the consequences of a range of agricultural systems, including conventional and genetically transformed crops as well as organic production, on agricultural sustainability, public health and environmental risk. The research will also encompass strategic issues concerned with changes in the balance between intensive and extensive agricultural production systems. The Department will consider mechanisms to increase the proportion of systems-based studies within its programme of research, particularly through co-ordination of the existing strengths within the sponsored bodies and by ensuring biomathematics is fully integrated within experimental programmes.

Implementation

3.17 In order to take advantage of these scientific opportunities and to maintain sufficient depth of research in areas of strategic relevance, it will be necessary to review the current breadth of the SOAEFD programme and rationalise certain areas. This is likely to lead to a number of shifts of emphasis within the research portfolio. The approach adopted will be:

- Maintain the primarily strategic nature of the programme, with a continued element of underpinning basic research, and an increase in work funded at the applied end of the spectrum where this is in support of policy or does not impinge on areas properly to be funded by industry;
- A further move towards ensuring there is critical mass and scientific depth of effort within strategically important areas of the programme;
- A refocusing and rationalising of certain components of the programme, to create the ability for increased funding for the areas of continuing and new priority.

3.18 These developments in the programme – and their detailed implementation – will be discussed jointly with the Department's seven main sponsored bodies, with end-user interests, with policy divisions in The Scottish Office, and with the other major funders of biological and related research. The majority of the programme will continue to be delivered through the five Scottish Agricultural and Biological Research Institutes with important components also being provided by the Scottish Agricultural College, and by the Royal Botanic

Garden, Edinburgh whose underpinning research programme in plant systematics and in biodiversity will be integrated into the programme's thematic structure. That thematic structure will also be revised to take account of the variety of changes in emphasis envisaged. The specialist unit Biomathematics and Statistics Scotland (BioSS) will continue to be strongly supported by the Department.

3.19 With these various changes and improvements to the programme the Department expects to be able to fulfil its objective for the strategic science base it supports.

4 OBJECTIVE 2 – KEY END-USES AND RELEVANCE

"To widen further the range of end-uses of the Department's research programme and to ensure the programme is relevant to the short, medium and long-term needs of its end-use sectors and Scottish Office policies for those sectors".

4.1 Traditionally the focus of the SOAEFD programme has been on agriculture and has been seen as such. In practice a trend which has been in evidence for some time is that the research base has moved away from a purely agricultural orientation and is no longer founded on the need for increased agricultural production. Many of the basic skills in the sponsored bodies are generic with strengths across a range of scientific disciplines such as animal and plant physiology, molecular and cell biology, soil science and systems research. This has enabled the programme to diversify and to have a bearing on a number of other end-uses such as primary product quality, human health and nutrition, environmental management, and the development of new industries. The relevance of the programme is however of a primarily strategic and long-term nature. And while there are Scottish aspects to most of these issues the science base has a role to play in their development in both the UK and international arenas.

4.2 The end-uses of the programme are therefore potentially very diverse and touch on a range of end-user communities, be they policy advisers, levy bodies, other industry representatives, primary and processing industries, and of course consumers and the public. The relevance of the programme to end-user communities has been reviewed with reference to:

- Priorities identified in the recent Foresight exercises;
- Developing needs of end-users identified during the consultation exercise;
- Existing coverage of the SOAEFD programme and that of other funders;
- Scientific strengths and capabilities of our sponsored bodies;
- The ability to adapt the programme to new areas.

4.3 The result of this analysis is that the research programme will now be developed in terms of the five science domains described in Chapter 3 and their relevance to five main end-use categories, namely: sustainable agriculture; environment and natural heritage; nutrition and human health; food and bioindustries; and rural communities and development. The following matrix

identifies the relationship which each of the domains has to each of the end-user categories, with a single entry indicating "some relevance", a double entry "significant relevance" and a triple entry "very high relevance". In taking forward the programme, the research within each domain will be developed with full regard to the end-uses to which it relates.

	Sustainable Agriculture	Environment and Natural Heritage	Nutrition and Human Health	Food and Bioindustries	Rural Communities and Development
Soil and environmental sciences	✔✔	✔✔✔	✔	✔	✔
Plant Science	✔✔✔	✔✔	✔✔	✔✔✔	✔
Animal Science	✔✔✔	✔	✔✔✔	✔✔	✔
Animal Health and Welfare	✔✔✔	✔	✔	✔✔	
Socio-economics and land use	✔✔	✔✔		✔	✔✔✔

4.4 The five key categories of end-use are described in the sections that follow. These end-uses are in many cases of international application but their relevance to Scotland in particular is mentioned here. Where there are other major funders of research relevant to these end-uses, these are also described: the SOAEFD programme is planned to be complementary to those of other funders.

Sustainable Agriculture

4.5 This section encompasses a major part of the outputs from the research programme. Sustainable agriculture requires balancing the use made of natural resources and the impact of agricultural practices on the environment with the industry's need to be economically viable. The programme aims to provide underpinning strategic research in support of agriculture and related industries selling produce onto world markets on world trade terms. This will be done while ensuring that the industry operates in a way which is as environmentally and socially acceptable as possible, taking account of the views and interests of both the rural population itself and the urban consumer. Research can identify ways of improving efficiency, particularly by reducing inputs, whilst producing the consistently high quality products which are now sought by the consumers and customers, and in a manner which minimises the use of chemicals and maximises crop and animal health and welfare.

4.6 The programme recognises that due to the diversity of Scottish terrain and climate both intensive and extensive systems need to be taken forward. The diversity of issues which contribute to sustainability in the agricultural context will continue to be addressed by research. These issues include topics such as animal and crop health, covering areas such as disease diagnosis, host-pathogen interactions, disease resistance, and reduced use of pesticides. Other examples of areas where the programme can assist are organic farming, which is increasing in importance, and precision farming approaches. Non-food crops, high value niche market products, and pollution, pesticide reduction and other environmental concerns will also be covered.

4.7 Agriculture accounts for a significant percentage of economic activity in rural areas where it is a major employer. Hill and upland areas of Scotland have particular research needs if economically viable, but environmentally and socially sustainable, agricultural production is to be conducted. Scotland's farmers need to operate within the Common Agricultural Policy, and the programme will require to adapt to the final Agenda 2000 CAP reforms.

4.8 Within the UK, MAFF and BBSRC are also major funders in this area, and clear understandings need to exist between SOAEFD, MAFF and BBSRC to ensure the research programmes remain complementary. Levy bodies such as the Meat and Livestock Commission (MLC), the Milk Development Council (MDC), the Home Grown Cereals Authority (HGCA) and the British Potato Council (BPC) fund more applied work of relevance to their industrial sectors. Efforts will continue to ensure good contacts between SOAEFD and the levy bodies.

Environment and Natural Heritage

4.9 The soil and environmental sciences research programme has gradually diversified into a wide range of environmental and ecological issues relating to agriculture and other land uses. In general terms the programme concerns the management of different Scottish ecosystems, the rate and nature of change as well as the consequences and the potential for remedying adverse effects.

4.10 Use of the outputs of the research will help assist in the sustainable management of the Scottish environment. Issues such as environmental protection including water quality, GM risk assessment, the maintenance of biodiversity and bioremediation of damaged environments will be taken forward by research. The programme will help policy advisors to model or consider the potential effects of proposals on the environment, including those emanating from the European Commission.

4.11 Studies of grazing ecology are of particular relevance to the protection of the Scottish agricultural landscape and research aimed at improving animal welfare by understanding the relationship between the well-being of livestock and the environment in which they are managed will also inform Scottish land management policies. In addition, programmes of research on herd health and welfare aimed at developing biological control of endemic diseases will reduce the need for environmental contamination by chemotherapeutic agents such as organophosphates and synthetic pyrethroids.

4.12 Scotland has an ecology that is characterised by uplands, grasslands and highly organic soils, which are not reflective of the general pattern throughout the UK. Upland pasture and coastal habitats are especially vulnerable to the effects of climate change and this could have a major impact on future land use patterns. There are particular biodiversity issues in Scotland which are not shared by the rest of the UK and interactions between the needs of agriculture and other land uses and biodiversity will be taken into account.

4.13 The programme in this area will take account of the much larger bodies of work funded by DETR and NERC, both of whom fund research relevant to the UK as a whole. Other cognate programmes are undertaken by MAFF, SNH, SEPA and The Forestry Commission.

Nutrition and Human Health

4.14 Nutrition is widely recognised as a major contributory factor to the maintenance of good health and avoidance of degenerative diseases in humans. There is a need for a clear understanding of the links between nutrition and health not only from health care and public health interests, but from commercial interests throughout the food chain from primary producers to consumers. The particular strengths of the SOAEFD-funded programme in the study of nutrition at the cellular level in animals and research on the control of intake and diet selection can provide an important contribution to this. Although the programme originates in studies on livestock, the knowledge and understanding gained is relevant to all animals including man.

4.15 In addition, the SOAEFD programme includes research on aspects of the nutrient content of primary food products of both plant and animal origin and also investigates how the nutritional quality of these may be improved through breeding, or new cultivation/husbandry systems. Addressing the needs for product improvement will require multidisciplinary approaches and consideration of the interactions within plant/animal systems. The SOAEFD programme is well placed to fund research which can address such complex questions.

4.16 Aspects of human health are also covered in the programme by study of zoonoses (infections of animals which are transmissible to, and cause illness in, humans). Research on microbiological safety of foods will become the province of the Food Standards Agency (FSA) when it comes into being. However, underpinning strategic research on intestinal microbial physiology and ecology such as factors affecting pathogen carriage in the gut will remain within the SOAEFD programme. In addition, relevant regulations such as Government or EC recommendations aimed at reducing antimicrobial resistance will be given due consideration in establishing future research priorities.

4.17 Research on nutrition and its relevance to human health are of interest to a number of other funding agencies including the EU, MAFF, BBSRC, MRC and the Chief Scientist's Office of the Scottish Office Department of Health. It is expected that the Food Standards Agency when it comes into being will have considerable responsibility in this area also. However it is an area of increasing interest and concern, identified by two different Technology Foresight panels as a priority for research, and the SOAEFD contribution to this research will be significant.

Food and Bioindustries

4.18 The general skills developed by scientists in the areas covered by the programme give insights into processes and generate innovative and advisory knowledge and expertise which is sought by industry, particularly the food and bioindustries.

4.19 Knowledge about the biology of primary food production can be used in understanding the effects of processing and other systems which enhance quality whilst adding value. Food is one of a number of "cluster areas" identified by Scottish Enterprise as of primary importance to wealth creation and the Scottish economy and a Scottish Enterprise "action plan" for this food cluster is currently in preparation. While the emphasis of the SOAEFD programme will be directed towards the understanding and manipulation of primary product quality, new priorities for research aimed at adding value at processing will be established following consultation with the sponsored bodies, universities with interests in this area, SOAEFD policy divisions and Scottish Enterprise.

4.20 Opportunities for joint funding of food processing or food materials research with industry through LINK initiatives will be encouraged wherever possible. The Department will support research to improve food processing in the absence of industry support where there is clear evidence of niche market advantage or potential for particular economic or health benefit to Scotland.

4.21 The bioindustries sector is economically important for the country as evidenced by a year on year growth in employment in the sector of 40% since 1993. The generic skills found within the Scottish science base which enable it to keep up in this fast moving area have helped to attract multi-national companies to Scotland in the last five years. Currently 48 companies employ over 3,500 people, which rises to 20,000 engaged in the sector when the 60 related supplier companies are taken into account. This is another of the key cluster groups identified by Scottish Enterprise as of strategic importance to the Scottish economy and for which an action plan is in preparation.

4.22 The SOAEFD-funded programme is already contributing to this growth area in actual research developments and, additionally, in the transfer and export of relevant skills and knowledge. For example, tools for research such as antibodies, immunomodulators, gene sequences and promoters can be adapted to commercial, medical or nutritional purposes such as vaccines, pharmaceuticals and molecular diagnostic tests. It is also likely that, as increased global trade competition drives the need for diversification within the traditional agriculture-based industries, opportunities will be sought to exploit the production of high value compounds such as phytopharmaceuticals in novel crops. There is considerable potential for the development of these technologies in Scotland and both SOAEFD sponsored bodies and centres funded by others are actively pursuing such research.

4.23 Major funders in these areas include BBSRC, MAFF and MRC. The Department will therefore coordinate work within the framework of all these programmes while maximising the benefit to Scotland as well as to the UK.

Rural Communities and Development

4.24 Rural development and the sustainability of rural communities are policy areas of increasing importance, and to some extent this is an overarching theme for a number of the other end-use categories. However both the matrix shown after paragraph 4.3, and these paragraphs here, have been compiled with reference to research and policies targeted specifically on this subject.

4.25 The needs and concerns of rural communities cover a diversity of issues and the SOAEFD programme is relevant to many of them. In particular, there is a need for economic and social aspects of agriculture, other land uses and the development of rural communities more generally to be investigated. This ranges across issues from land reform policy, the diversity in how land is owned and used,

and the links between agriculture and other rural industries to the implications of policy changes on the rural economy. Those developing strategies for rural industries to respond to lower or different support policies will be able to use this work. Alternative ways of using the land or agricultural output as well as diversified opportunities for economic development will be sought. Examination of how much agriculture contributes to the rural economy, and analysis of the drivers of rural development, will be taken forward.

4.26 Rural development is important within the Scottish context because 90% of the landmass is non-urban and although a substantial proportion of the population lives in rural areas they are sparsely distributed. The rural areas of Scotland are a particular asset to the country and it is important that sustainable development in rural areas benefits those living and working there as well as the population of Scotland more generally. Land, its use and management is therefore of great importance to these areas.

4.27 Other funders active in this area include the Economic and Social Research Council, DETR and the Department's own rural research programme. Future work will be co-ordinated with these funders while having a particular bearing on Scottish circumstances.

Mechanisms

4.28 Having identified this broader range of end-uses for the outputs from the research programme the challenge is to ensure that current and potential end-users are aware of the work and able to benefit from it. To assist with this SOAEFD intends to implement the following mechanisms:

- The Department aims to widen the range of end-use sectors to give new emphasis to the environment, rural communities, food, diet and nutrition, human health and biotechnology by building on the above outline and examining the relevance of the current core programme. The end-use relevance will also be considered when new core-funded research is commissioned.
- The Department will ensure a greater involvement of policy divisions and enduse sectors, by involving them in the specification of projects and programmes and in a series of "topic reviews" which will examine different subject areas of the research programme in turn.

- SOAEFD already includes end-user interests in the five-yearly peer review of our sponsored bodies. The Department will now include policy interests in the peer review process also to enhance the assessment of the relevance of the work.

5 | OBJECTIVE 3 – Quality and Effectiveness

"To enhance the quality and effectiveness of the research programme through improved focus and direction, co-ordination, collaboration and competition".

5.1 To respond to the views expressed during the Strategy Review that further potential exists to enhance the quality of the scientific programme, the Department aims to implement a broad set of mechanisms to increase effective co-ordination, collaboration and competition where these will add value. The Department will also work with sponsored bodies to examine some issues relating to institute management. The Department will continue to use the Visiting Group system of peer review of its sponsored bodies, but will re-appraise that system in advance of the next round of Visiting Groups (planned for the years 2002 and 2003) in order to seek improvements and accommodate the changes set out in this Strategy.

Increased Co-ordination of Core Programmes

5.2 A number of factors in recent years have contributed to the need for the Department to take a fresh look at co-ordination and management of its grant-in-aid programmes funded through the core programme at sponsored bodies. The core grant has been level in cash terms for a number of years, and coupled with the increasing costs of undertaking research and the increasing complexity of possible research activities, this has meant that some of the work in the sponsored bodies no longer has the critical mass to continue to remain competitive. Recent Visiting Groups to the Department's sponsored bodies expressed concern that there is a need for re-focusing some of the research programmes within organisations. To address the above problems in areas of continuing strategic importance, and to deliver better value for money, the Department will encourage more effective co-ordination, within the core programme, of the research effort across the sponsored bodies taking account of the contribution made by non-core funding from other sources such as industry .

5.3 A system of co-ordinated programmes has been operated by SOAEFD since 1991. This will be extended and enhanced in discussion with the sponsored bodies. Areas will be selected for co-ordinated programmes where:

- Research is in cognate areas;
- Complementarity of approaches exists within the grant-in-aid funded organisations;

- The co-ordinated programme will allow the sponsored bodies to make the most of opportunities for multi-disciplinary research;
- The work will take advantage of new scientific opportunities and address important scientific and policy questions;
- The co-ordinated programme will not jeopardise the role of the individual organisations or cut across their unique remits and missions.

5.4 In addition to these discussions the Department will consult external specialist advisors and end-users through the mechanism of topic reviews or workshops to help identify appropriate areas for co-ordinated programmes. The Department will also conduct a review of existing co-ordinated programmes to ensure they remain relevant to their initial aims and strategic objectives as well as the criteria above. Some refocusing of programmes may result.

Collaboration

5.5 Collaboration occurs both at the scientist and institute level, as well as the funder level. The sponsored bodies already have mechanisms for fostering collaboration, most notably the Committee of the Heads of Agricultural and Biological Organisations in Scotland (CHABOS), and the Department will encourage the further development of these mechanisms. To secure additional collaboration between the sponsored bodies and other research organisations within and outwith Scotland, including Higher Education Institutions, the Department will encourage collaborative bids to the Flexible Fund to address specific opportunities and needs not covered by individual or co-ordinated grant-in-aid programmes. The Department will be looking for effective collaboration to produce an impact which adds value to the individual contributions without diluting the focus of the sponsored bodies' respective programmes.

5.6 In particular the Department will seek closer collaboration between our sponsored bodies and the Higher Education Institutions through joint funder initiatives. Collaborations will only be promoted where there are clear synergies. The planned SOAEFD and SHEFC initiative to create a centre of excellence in veterinary science through the vehicle of the Flexible Fund offers an opportunity to pilot this approach prior to extension to other fields.

5.7 As another mechanism to foster collaboration between the sponsored bodies, Higher Education Institutions and other research providers, SOAEFD intends to continue funding joint initiatives with the Research Councils where this

is deemed appropriate and relevant. A further benefit of joint funding in this way is that all funder schemes are opened more widely to other bodies to enable them to compete with each other for the funds and to thereby raise standards. Existing mechanisms for co-ordination between SOAEFD and other funders such as Whitehall Departments and Research Councils will be developed to ensure that through the devolution process, activity and understanding are maintained.

5.8 The Department will continue to apply resources to create packages of funding for collaborative projects or strategic alliances with industry, for example through the LINK scheme or the co-funding of equipment with the private sector. Joint funding with the European Union's Framework Programme V will also be taken forward in discussion with the sponsored bodies and mainly through the grant-in-aid mechanism.

5.9 Within Scotland stronger general links will be built with SHEFC and other funders of environmental, fisheries, forestry and rural development research. And in particular the Department will examine the scope for a stronger integration of its own research programmes in these areas, including those carried out through its agencies or other sponsored bodies as set out briefly in Annex B.

Competition

5.10 It is generally acknowledged that competition for funding brings an added cutting edge and innovation to research. Feedback during the consultation exercise sought more competition between the sponsored bodies for the Department's funds. Currently the Department opens only the Flexible Fund to competition and at present of this some 40% is let by open or limited tender involving a peer review of the bids: most of the remainder is deployed on collaborative or co-ordinated multi-disciplinary programmes covering a number of the Department's sponsored bodies or universities and other research organisations. SOAEFD intends to enhance competition through three approaches:

- Increasing the proportion of the Flexible Fund subject to a competitive tendering process and including a system of peer review for all projects both at the appraisal and evaluation stages. Included in this will be a limited number of senior fellowship posts in areas of increased scientific opportunity;
- Requiring sponsored bodies to bid for an element of the Department's core grant-in-aid budget, either individually or jointly, to take advantage of the scientific opportunities and priorities, and the end-user needs, identified in this Strategy;

- Introducing competition for the major part of core funding by linking the distribution of that funding to the five-yearly Visiting Group-based assessment exercise. The Department aims to include this type of assessment in the next round of peer review starting in 2002 following consultation with the sponsored bodies and others during 1999, and publication thereafter of the details of the assessment exercise by which the sponsored bodies' programmes will be judged.

Institute Management

5.11 Striving for international excellence requires a long-term commitment to the career development of staff. The Department will explore with sponsored bodies how to meet the need to recruit and retain high quality innovative scientists. Together with the sponsored bodies the Department will consider:

- Whether the current balance between fixed-term and indefinite contract staff is appropriate;
- Encouraging research staff to make more use of research leave to learn from cutting edge groups;
- The scope for flexible working between core research programmes and the more commercial work in subsidiary companies.

5.12 The sponsored bodies are currently considering the provision of management training for research staff and the CHABOS Scottish Management Advisory Committee (SMAC) are disseminating information on best practice to all sponsored bodies. The Department, for its part, will consider best practice within the public sector and share this information with SMAC. The Department will also explore with the sponsored bodies the scope for making more use of SMAC in arranging the carrying out of common administrative functions and services on a joint basis.

6 | OBJECTIVE 4 – KNOWLEDGE TRANSFER AND EXPLOITATION

"To foster knowledge and technology transfer from the science base to the end-users."

6.1 On top of advancement of science SOAEFD sees two uses of the knowledge generated from the science base: transfer of the relevant results to end-users within Scotland; and wealth creation through the ability to identify, interpret and develop scientific discoveries with commercial potential. Although there is some overlap of these two categories, this Chapter considers each of them in turn.

Knowledge Transfer

6.2 Most agriculture-related knowledge transfer from the Department's programme has historically been delivered through the Scottish Agricultural College. SAC has traditionally provided advisory services and training to the farming industry (much of it now on a fee-charged basis) to encourage widespread adoption in Scotland of identified good practice. Within its education function, funded largely by the Department, SAC involves students in research, contributing to knowledge transfer in the longer-term. SAC also places a significant number of students in farms and other rural businesses as an integral part of their education provision; this not only enables farm workers to attend SAC courses as a result but can also encourage knowledge transfer. SAC has developed educational links with HEIs and RBGE, providing an opportunity for collaboration and cross-fertilisation between these organisations.

6.3 The consultation exercise confirmed that there is scope for improving the dissemination of information across the base of end-users beyond the farming and traditional land-based communities. In recent years SAC has diversified its knowledge transfer function to embrace a wider range of rural activities and land use. Other sponsored bodies and service providers may also, however, be well-placed to access the wider end-user communities and transfer knowledge from the less agricultural aspects of the science programme. Opportunities for doing this whilst not jeopardising potential income from intellectual property will be explored.

6.4 RBGE has a significant interface with the general public through its public and schools education department. It is also the third most popular tourist attraction in Scotland. RBGE has a varied programme including adult and schools'

education, outreach and exhibitions and has established itself as a major venue within the annual Edinburgh International Science Festival, often collaborating with other sponsored bodies. This will be examined to see if more use can be made by other sponsored bodies or the Department of this unique facility.

6.5 To develop knowledge transfer further a number of approaches will be followed:

- Knowledge transfer will be considered in more depth by the sponsored bodies and the Department at the time a project or programme is conceived, especially where the research is more applied in nature;
- Sponsored bodies will be encouraged to widen their base of end-users, increase the involvement of end-users at all stages and examine the scope for tailoring their communication strategies to particular user groups. This will include policy divisions in The Scottish Office for whom the research organisations can provide a valuable source of advice and information for the development of policy;
- The Department will review existing systems of knowledge transfer through SAC education and advisory services and through related activities of the commercial subsidiaries of the SABRIs, SAC and RBGE;
- The Department will hold or fund research workshops targeted at specific users;
- The Department will evaluate research projects as they are completed to identify the extent of potential knowledge transfer and the methods to be employed to secure it;
- The funding of core programme projects will include an allowance, where appropriate, for knowledge transfer activity from the projects; and the Flexible Fund will be used to fund specific and well-focused knowledge transfer activities;
- The Department will participate in the Teaching Company Scheme by which researchers are funded to spend a period in industry applying research knowledge and techniques.

Exploitation of Research

6.6 The Department's sponsored bodies have established commercial subsidiaries to attract profitable commercial funding for exploiting and developing the scientific discoveries. In 1993 SOAEFD gifted the Intellectual Property Rights

arising from research funded by the Department to the sponsored bodies for them to exploit in this way on condition that all the costs associated with development are covered and any resulting profits are returned to the publicly-funded body.

6.7 The sponsored bodies have been successful at generating turnover from their expertise. The challenge in future years will be to build on this success and broaden activity to enhance wealth creation and economic activity in Scotland. The recently published Competitiveness White Paper sets out priorities for the UK in future years in order to exploit technologies and develop competitive advantages. It states that the Government is determined that the Public Sector Research Establishments make the most of the commercial potential of their research outputs. This provides an added impetus to the need to exploit commercial opportunities arising from agricultural and biological research undertaken on behalf of AEFD.

6.8 Commercialisation will best be achieved through a balance of potential routes including licensing, assigning rights, embarking on joint ventures, and creating spin-out companies as well as using the subsidiary company model. These will need to be developed whilst ensuring that potential conflicts of interest are tackled.

6.9 To increase the benefits derived from exploitation of the science base the Department will:

- Work closely with The Scottish Office Education and Industry Department as well as Scottish Enterprise in their research innovation and commercialisation strategy to link the agricultural and biological science base to new developments;
- Encourage sponsored bodies to improve bilateral links with their Local Enterprise Companies;
- Consider with sponsored bodies the extent to which their commercial support functions can be pooled to create critical mass and attract strong and affordable patenting, finance and business support, perhaps through the mechanism of SMAC;
- Explore the potential for research leave or other flexible working arrangements to be adopted to allow scientists to pursue the commercialisation of their outputs as well as examining the opportunities for scientists to take a financial stake in developments;

- Review its current IPR policy to ensure commercialisation is promoted effectively and efficiently;
- Consider with sponsored bodies the introduction of carefully tailored performance indicators in this area.

7 | OBJECTIVE 5 – INFORMATION AND PUBLIC AWARENESS

"To improve information dissemination from and public awareness of the research programme and its outputs".

7.1 During the Strategy Review consultation process, the Department found that the depth and quality of the contribution of the SOAEFD programme to the national and international scientific effort, as well as its relevance to end-users in industry and Government, were highly regarded by those who had come across the work but were not in fact widely known. The consultation exercise suggested that the Department should raise its profile and so encourage the creation of further links with industry and other users as well as stimulate wider dialogue between scientists about the programme. By raising the profile of the SOAEFD commissioned research, and of its strategy for the programme, the Department wishes to:

- Bring about greater awareness of the Department's research programme, particularly that being carried out by its sponsored bodies;
- Promote the relevance of the research outputs to a wide variety of end-use communities;
- Publicise the achievements of the research programme;
- Bring about greater awareness of the Department's relationship with other science funding throughout the UK through complementarity of programmes and collaboration of funding.

7.2 At present SOAEFD promotes its research programme by periodically publishing its Strategy (last published 1993) and by producing an annual "Themes" document of all its commissioned research projects grouped by subject area. The Department has identified further scope to improve the information available and reach a wider audience and will do this by:

- Developing a Website to include information on the Strategy, research programme, sponsored bodies, finance details, and requirements for competitive funding applications as well as research achievements;
- Producing a range of publications to cover the outputs of the programme, advances in basic knowledge, successes in technology transfer and details of initiatives. These will include an Annual Report on the Department's commissioned research as well as periodic newsletters;

- Identifying and publicising particular successes from the research programme which have led to improvements in efficiency or resulted in change of practice;
- Organising workshops and seminars targeted at specific end-users;
- Identifying issues of particular public interest and presenting relevant information about them in conjunction with other bodies such as research organisations or the Royal Society of Edinburgh;
- Increasing the two-way flow of information between Scottish Office policy makers and scientists in sponsored bodies;
- Exploring how to make use of facilities such as the exhibition space within the RBGE as well as in Scottish Office buildings to reach a wider audience through a display of information;
- Increasing liaison with other funders to promote information exchange.

7.3 SOAEFD sponsored bodies each produce and circulate Annual Reports on their work as well as Corporate Plans. The Department will encourage these organisations to raise their profile still further and in particular to bring their work to the attention of the full range of policy divisions in The Scottish Office with a potential interest as well as the wider range of other end-users.

8 FUNDING AND SCIENCE BASE INFRASTRUCTURE

8.1 Although, like the rest of the Government's spending plans in Scotland, they fall to be reviewed by the new Scottish Executive and Scottish Parliament, the projected funding figures for the main blocks of the Department's expenditure programme are shown in the following table. These include the Department's funding not only of research (some £50m) but of the related further and higher education, advisory services, and veterinary surveillance activities at SAC, and the botanical collections and public education programmes at RBGE:

£m	1998-99	1999-00	2000-01	2001-02	2002-03
Grant-in-aid to SABRIs, SAC, RBGE	47.1	48.3	49.0	49.7	50.4
Superannuation	10.8	11.4	11.9	12.2	12.5
Flexible Fund	6.2	6.3	6.3	6.3	6.3
Capital Grant	2.4	4.1	5.1	7.1	7.1

8.2 At present, grant-in-aid to the SABRIs is projected to rise at 1.5% per annum in cash terms. This assumes that SABRIs will continue to achieve efficiency gains and to generate additional external income to make a contribution to pay and price rises or to expansion of research effort. The SAC grant-in-aid for research and advisory services is projected to increase by similar percentages but that for education is to remain roughly constant in cash terms. The Royal Botanic Garden, Edinburgh grant-in-aid is projected to increase by 1.5% also. The allocations to the SABRIs, SAC and RBGE for 2000-01 and later years will, however, be reviewed in the light of this Strategy document.

8.3 The vast majority of employees in SAC and the SABRIs participate in the joint SOAEFD Superannuation Scheme which is funded centrally by analogy with the Principal Civil Service Pension Scheme, and the required provision for this over the period of this document is made. The Flexible Fund is projected to remain constant at £6.3m. Capital expenditure is projected to rise from £2.1m in 1998-99 to £7.1m in the years 2000-01 and 2001-02 and beyond.

Changes to Core, Flexible Fund and Capital Funding

8.4 The changes to core, Flexible Fund and capital described throughout this document will be managed within the funding envelopes set out above. In summary the changes to core funding are as follows:

- The science programmes at the sponsored bodies will be expected to reflect the science priorities described in Chapter 3 and Annex C and the end-user categories set out in Chapter 4;
- They will increasingly reflect the input of Departmental policy divisions in discussions with the sponsored bodies about their grant-in-aid programmes;
- They will also be informed by Department-led 'topic reviews' in which subject areas will be considered by panels including external advisers, sponsored bodies, policy divisions, end-user sectors, and other funders;
- Core programmes will be more co-ordinated across sponsored bodies where different institutes operate in cognate areas;
- The content of the individual core programmes will evolve following discussions between the Department and the sponsored bodies in the light of this Strategy;
- The Department will move towards awarding core funding competitively.

8.5 There will be implications for the Department's funding of Non-Commissioned Research (NCR) whereby sponsored bodies have a free hand in the use of some funds within grant-in-aid for 'seed-corn' work. This facility is an important component of the science base supported by the Department and enables Directors and staff of the sponsored bodies to take advantage of rapidly emerging new scientific opportunities without reference to the Department. The SABRIs will be encouraged to use the allowance they already have for this work (5% of their total grant-in-aid programme), and at SAC the NCR programme will be focused on this 'seed-corn' element and accordingly reduced to 5% in line with the SABRIs. The other elements of SAC's NCR programme will be reviewed within the commissioned ROAME system; some of the existing NCR funding at SAC may transfer to the education and advisory services programmes.

8.6 The changes to the Flexible Fund can be summarised as:

- Increasing collaboration through joint funder initiatives;
- Expanding peer review to cover all projects at the appraisal and evaluation stages;

- Increasing competition by awarding more projects by open or limited tender call;
- Increasing the proportion of the Fund used to support applied policy-related work;
- Using the Flexible Fund for knowledge transfer activities;
- Participating in the Teaching Company Scheme;
- Awarding senior research fellowships in priority areas.

8.7 The Government has significantly increased the funds available for capital funding at the sponsored bodies as a result of the 1997-98 Comprehensive Spending Review. SOAEFD will target the spending to ensure it reflects the scientific priorities set out in this document.

Sponsored Bodies

8.8 The remits of the SABRIs, SAC and RBGE are described in Annex A. These sponsored bodies will continue to form the main science base supported by the Department and to conduct the majority of the Department's research programme. The Strategy describes the Department's plans and priorities for its research programme over the next four years, and the process of developing the research programme will be conducted in partnership with the Department's sponsored bodies, with any implications for changes at the sponsored bodies being discussed in full with them.

8.9 As already noted, the Directors and Chief Executives of the SABRIs, SAC and RBGE, along with the Directors of SASA, FRS and the Forestry Research Agency, have formed the Committee of the Heads of Agricultural and Biological Organisations in Scotland (CHABOS). The Department will seek to increase its interaction with CHABOS, and participate in its initiatives. This may be a useful vehicle for taking forward a number of the steps proposed in this Strategy. In particular the Department wishes to encourage a wider role for the SMAC Committee of CHABOS to realise any further gains in efficiency and effectiveness which the shared consideration and provision of services can generate.

8.10 All seven of the main sponsored bodies receive grant-in-aid from the Department. This is supported by formal Management Statements setting out the respective roles of the sponsored bodies and the Department. These Management Statements will be reviewed in conjunction with the sponsored bodies during the

period of this Strategy. It is also likely that during this period a further round of quinquennial Policy and Financial Management Reviews will be conducted. Regular discussions with the sponsored bodies about their corporate plans will continue.

8.11 The Department's strategy for its sponsored bodies continues to rely on them securing external funding to supplement core grant-in-aid funding and Flexible Fund contracts. In recent years the sponsored bodies have been very successful in increasing this external funding, whether from other grant-awarding bodies or through the development of commercial subsidiaries or sister companies through which the research and services of the sponsored bodies are marketed. The Department will encourage the sponsored bodies to develop these other streams of income further, and a number of the measures identified in Chapter 6 are geared to achieving this.

Conclusion

8.12 In conclusion this Strategy identifies the Department's main objectives for its agricultural, biological and related research programme, and sets out its priorities and plans for achieving these objectives over the period to the year 2003. The Department will take forward this Strategy in discussion with its sponsored bodies, with the wide range of end-users of the programme, and with other funders of cognate research elsewhere in the UK.

A MAIN SPONSORED BODIES

A.1 The **Hannah Research Institute** is a world centre for the generation of new knowledge in biological science and technology of relevance to relations between mother and offspring, to harnessing lactation for nutritional and economic benefit including cognate areas of biotechnology, and to the quality of food products.

Key features are:

- That its functions are vertically integrated, spanning and linking the consumer to the efficiency and sustainability of productive processes;
- Research at all levels of biological organisation from the whole animal to the molecular;
- Close and formal links to the Universities of Glasgow and Strathclyde;
- Specialised facilities beyond the laboratory, including: controlled pilot-plant for investigating the underlying physical processes involved in food products; sensory panel and associated statistical analysis; large animal science.

A.2 The **Macaulay Land Use Research Institute** undertakes research in the context of rural land use and resource management. It assesses the environmental, economic and social impacts of agriculture and related land uses together with the consequences of change resulting from factors and influences such as policy, management, effects of climate and pollution.

Key features of the Institute are:

- Its thematic programme supporting the concept of sustainable development;
- A cadre of multi-disciplinary research staff in the field of soil, plant, animal and ecological sciences, geography, socio-economics and information technology;
- Its major database for soil, land cover, climate and other natural resource information for Scotland;
- A subsidiary company, Macaulay Research and Consultancy Services, that acts as a route for technology transfer and the exploitation of research findings.

A.3 The **Moredun Research Institute** conducts basic and strategic multi-disciplinary research on the biology of infectious diseases in sheep and other grazing animals that contribute to national wealth, are integral to sustainable agriculture and underpin the economy of the Less Favoured Areas.

Key features are:

- Its location at the hub of a new £23m bioscience park developed by the Moredun Foundation, co-located with other animal health research groups and kindred SMEs;
- Close links with the University Veterinary Schools of Edinburgh and Glasgow, an unparalleled resource for integrated animal health research;
- Interactive links with field and advisory services to facilitate epidemiological investigations, disease surveillance and early awareness of emerging problems;
- Moredun Foundation and subsidiary bodies to promote technology transfer and exploit research discoveries.

A.4 The **Rowett Research Institute** conducts strategic multi-disciplinary research on biochemical and physiological aspects of mammalian nutrition, with particular emphasis on the effects of diet on health and on the complex interplay between agriculture, food and health.

Key features of the Institute include:

- Its ability to conduct integrated research on both animal and human nutrition and to combine studies at molecular and cellular levels with those on whole animals;
- Strong national and international links, often supported by formal agreement, with a wide range of research institutions;
- State of the art analytical and spectrometric equipment, extensive animal facilities, calorimeters, metabolic suites, a human nutrition unit, and other equipment and facilities necessary for strategic studies on animal and human nutrition;
- A subsidiary company, Rowett Research Services, to promote technology transfer and exploitation of research discoveries.

A.5 The **Scottish Crop Research Institute** undertakes an integrated programme of fundamental and strategic multi-disciplinary research on agricultural, horticultural and industrial crops, their pests and diseases, and on processes common to all plants to create and protect wealth, and to improve the quality of life and the environment.

Key features are:

- Its ability to tackle any plant-related topic from the molecular level through single cells and crop plants to whole ecosystems;
- Unrivalled facilities and instrumentation for a wide range of biophysical, biochemical, genetic and pathological studies on plants and access to novel germplasm collections;
- Novel platform technologies for plant genomics research and plant biotech applications;
- A subsidiary company, Mylnefield Research Services, to assist with technology transfer and exploit research findings.

A.6 This Institute includes **Biomathematics and Statistics Scotland** which contributes research, consultancy and training in statistics and mathematics to support the biological science base in Scotland.

A.7 The **Scottish Agricultural College** integrates, within one organisation, research and development, education and consultancy services. Its multi-disciplinary research programme covers farming systems, environmentally clean technology, animal health, plant and crop science, crop health, soils and nutrient cycling, genetics and reproduction, nutrient supply, animal welfare and behaviour, and socio-economics.

Key features are:

- An extensive network of research and scientific project partnerships with 20 UK Universities and academic institutions in 36 countries overseas;
- Provision of advice and consultancy services within and outwith Scotland supported by the research programme;
- Close working relationships with national industry bodies and involvement with industry initiatives;

- Links with all the major rural agencies in Scotland and membership of the National Rural Partnership;
- Provision of diploma, undergraduate and post-graduate education;
- SAC Foundation and subsidiary companies to promote technology transfer and exploit research discoveries.

A.8 The **Royal Botanic Garden Edinburgh** is one of the foremost international centres for the study of whole plant and fungal science and plantsmanship, emphasising the diversity and systematic relationships of plants in order to understand their evolutionary mechanisms, environmental significance and conservation value.

Key features include:

- Extensive research and advisory coverage of most plant and fungal groups world-wide using traditional and technologically advanced networks;
- Numerous international and national collaborative links with many HEIs, research institutes and non-governmental organisations;
- Extensive, globally recognised collections of living and preserved plants and fungi, maintained as a Scotland-wide network of four gardens;
- Provision of undergraduate, post-graduate and professional training courses;
- Its status as a major tourist attraction and public amenity, thereby promoting public education and the broader understanding of science.

B | OTHER SOAEFD-FUNDED RESEARCH

Environment

B.1 A number of SOAEFD-funded bodies operate in this broad area.

B.2 The Scottish Environment Protection Agency (SEPA) is a Non-Departmental Public Body which conducts the majority of its research through the Scotland and Northern Ireland Forum For Environmental Research (SNIFFER). SNIFFER has an annual research budget of approximately £0.5m and an aim to promote scientific research in areas of water, waste, air and the environment and to subsequently disseminate the results. SNIFFER operates through a number of research advisory committees: waste and contaminated land; air pollution; Integrated Pollution Control (IPC) and radioactive substance; water pollution and water resources; and strategic cross cutting issues. In 1998 SNIFFER was funding approximately 50 research projects through these committees.

B.3 The science conducted by the NDPB Scottish Natural Heritage (SNH) is similarly linked to statutory requirements. The programme is quite broad including agricultural impacts and issues such as red deer, grazing, ornithology and biodiversity at the species rather than systems level. SNH spends approximately £3.5m per annum on surveys, monitoring, co-ordination and research which is central to its work in order to assist the development of policy, the provision of advice (through SNH advisory services) and practical environmental management. The work includes habitat change, landscapes and access, fragmentation of habitat, upland grazing regimes, lowland changes of habitat and the link into Targeted Inputs for a Better Rural Environment (TIBRE), as well as spanning marine and terrestrial habitats.

B.4 The Department funds a £0.5m programme of social and policy research on rural and environmental issues.

B.5 The Forestry Commission purchases around £10m per annum of research to support its objectives to protect woodland, to expand woodland, to enhance biodiversity, to improve the public understanding of science, to improve the recreation aspect of woodland and to add economic value.

B.6 For other research knowledge in the environmental arena Scottish Office policy divisions make use of the science funded by DETR, NERC, the Environment Agency, and the United Kingdom Water Industry Research Establishment as well as being closely involved with SNIFFER.

Fisheries

B.7 Fisheries Research Services (FRS) is a Next Steps Agency whose function is to provide support for the statutory duties of SOAEFD. FRS spends around £15m per year and provides quality advice on stock assessment and other stock issues needed to establish quotas; advice on technical conservation needs such as net mesh sizes or the establishment of closed areas to protect juvenile fish; and underpinning work and advice on the interaction with the wider ecosystem including issues such as fish disease, hygiene, movement and control. Around 75% of the funds are disbursed in supporting this advisory role with the remainder contributing to underpinning research and development work.

B.8 There are areas of commonality of subject matter between the work conducted at FRS and that in the Department's main agricultural and biological research programme. These areas include environmental research, biodiversity, pollution, microbial contamination, genetics and breeding and growth development, and health and welfare. These areas form a focus for collaborative projects between FRS and other SOAEFD sponsored bodies and there is potential for further co-ordination based on complementary expertise in particular scientific disciplines including: immunology, genetics, modelling (eg ecosystems, population dynamics, predator-prey relationships), molecular biology, epidemiology, parasitology, microbial contamination, analytical and environmental chemistry.

C | RESEARCH PROGRAMME PRIORITIES

C.1 This Annex provides the Department's assessment, under each of five domains, of the programme's strengths and weaknesses, future development, and relevance to end-users, building on the analysis set out in Chapters 3 and 4.

Soil and Environmental Science

C.2 The research within the soil and environmental science domain is appropriate for SOAEFD support and is generally of a nationally competitive standard. Research related to soils is a recognised Scottish strength, and this body of expertise is an integral component of the UK science base, and in soil physics and soil microbiology the work is internationally competitive. Soil microbiology, soil physics and soil protection will be priority areas in the soil and environmental science domain of SOAEFD's future research strategy. There will be an increased emphasis on the root/soil interface to build on strengths in soil microbiology and soil physics, to link more closely with the plant science domain and take advantage of a perceived gap in the UK science base.

C.3 Over the past decade SOAEFD has commissioned a considerable amount of research on wastes and pollutants research. This is now a maturing area of science and consideration will be given to rationalising those areas that are no longer of strategic importance to short or long-term policy needs. Research on gaseous emissions from soils will be reviewed to take account of the significant body of research that has already been undertaken and the strengths that exist at other institutes and universities in the United Kingdom.

C.4 The programme of water-based research is nationally competitive and aligns well with Scottish Office policy requirements. There is scope for this area of research to be internationally significant. Consideration will be given to mechanisms to capitalise on this area of strength and to improve the accessibility of the outputs to end-users. Relevant end-users will be involved at an early stage in research strategy formation in this area to ensure that the outputs are of the highest potential utility. Water management research is an area where other sponsors are particularly active, including NERC, MAFF, Environment Agency, SNIFFER and the Water Industry. The potential for joint funding of research and co-ordination of programmes to add benefit is significant. As a result of this Strategy Review efforts will be made to further co-funding and collaboration opportunities in water management research.

C.5 Studies on land management will have emphasis placed on research of sustainable farming systems, particularly extensive grassland systems to include soil fertility and nutrient cycling, vegetation dynamics, grazing ecology and resource management. Added value to SOAEFD's biodiversity research will be achieved by aligning some of the activities of the RBGE with catchment studies at MLURI and species and site-specific research commissioned by SNH. This will also increase the utility of the research to end-users. Studies of biodiversity and natural heritage currently appear in a number of Themes, these will be brigaded together to encourage synergy and added value.

C.6 As a result of this Strategy Review five end-use categories have been developed to describe those areas where SOAEFD looks to provide utility from research it commissions. It is unsurprising that this domain is highly relevant to the environment and natural heritage community, the soil and environmental science domain is the least mature of the domains within the research portfolio and has already been influenced by policy divisions to a greater extent than other areas. Notwithstanding this, there is still significant scope within the portfolio to engage end-users and other funders more significantly in the formation of research strategy at the pre-commissioning stage and then later in monitoring and evaluation activities. Since much of the soil and environmental science domain considers the management of agricultural practices in a manner that is sustainable and environmentally sympathetic it is highly relevant to the rural communities and development end-user community.

C.7 The general relevance of the current programme to the development of sustainable farming practices indicates the strength of the underpinning science in this area. Integrating this domain more with research in areas such as animal health and welfare, together with a new emphasis on sustainability will significantly heighten the relevance of the programme to this end-user sector. This domain currently makes little contribution to the food industry and biotechnology sectors. However, the fastest growing area of the food industry is the provision of 'organic' produce. Increasing the emphasis of the agri-environment domain on sustainability and systems research will significantly increase the utility of this area of the research portfolio to this end-user community. The agri-environment domain is relevant to nutrition and human health in areas of pathogen transmission through wastes and through research that improves the provision of high quality water.

Plant Science

C.8 The SOAEFD programme of plant science research is distinctive through its focus on key mandate crops and supporting programme of strategic underpinning research. SOAEFD-funded plant science research is generally of international or nationally competitive standards. Access to and use of key germplasm collections is a key feature of the programme. These collections contain novel sources of resistance and genes encoding agronomically-important traits (QTLs) which are identified and mobilised in the germplasm enhancement (crop breeding) programmes for potato, spring barley and soft fruit. The screening of germplasm collections, combined with both conventional breeding and modern molecular approaches including genomics, is a major strength in the programme.

C.9 Other SOAEFD-supported collections include the living and preserved plant and fungal collections held at the RBGE. These collections are used for systematics research (floristics and monographic) and to investigate the evolutionary relationships between plants. The results from this work both aid the development of conservation strategies and inform international policy, for example the Biodiversity Action Plan.

C.10 Within the plant science programme as a whole, the strongest specific area of research, which is internationally competitive, is the work undertaken on plant viruses (molecular virology and applied virology), and cell imaging and mRNA splicing in plants are also highly regarded. The mycology and bacteriology components of the pathology programme are strongly focused on the main pathogens of potato (*Phytophthora* and *Erwinia*) and are well regarded.

C.11 The main change in the plant science programme will be an increased effort in the application of genomics/functional genomics research, in particular within the barley programme and, to a lesser extent, within the potato programme. In order to accommodate this change, the existing balance of effort between conventional and molecular approaches to plant breeding will need to be redirected towards fundamental research which underpins and informs crop improvement. It is recognised that there is seen to be a continuing need for both conventional and molecular approaches to crop improvement. Consideration will be given to the inclusion of research on winter barley within the SOAEFD programme. The enhanced genomics effort will include the identification and mapping of molecular markers and quantitative trait loci (QTLs) of agronomic importance, accompanied by a greatly increased effort in functional genomics, with an aim to understand and adapt key agronomic features. There is considered

to be scope for far greater collaboration with other centres specialising in genomics research, including groups outwith Scotland and mechanisms will be developed to aid this.

C.12 The programmes on the maintenance and screening of some germplasm collections are not seen to be delivering relative to the financial commitment and newer methods of targeted molecular screening of germplasm collections will be encouraged. Systematics and pure botanical research will continue to be an important component of the SOAEFD programme. However, where appropriate, efforts will be made to integrate some of the RBGE's research activities with complementary interests elsewhere in the Scottish System.

C.13 There will be increased effort in systems-level research with work on populations, communities, crops and ecosystems. This will include plant science research at a number of different scales, from studies on specific ecosystems to research focusing on the effects on ecosystems of different farm management practices. There will be a new initiative on soil:root interactions. Within the pathology programme a strong focus on underpinning strategic science will be maintained, however, there will also be a new emphasis on epidemiology in particular of the pathogens and viruses affecting the high health status and reputation of Scottish seed potatoes. Multi-disciplinary work, including the development of programmes which link core work in related areas in different organisations, will be encouraged to aid the development of systems-type research.

C.14 Greater consideration will be given to research which demonstrates synergy through links between projects, or with other work funded by the Department. Areas of plant science, which do not appear to have sufficient critical mass, which are thought unlikely to yield science, at least of national significance, will be critically reviewed.

C.15 There will be an increased emphasis on ensuring that research meets end-user needs. It is recognised that the end-users of SOAEFD plant science research now extend to far more than those involved in agricultural interests and the future programme will have to meet both current and future end-use needs. This will include plant research relevant to the environment and to alternative forms of land use. The possibility of supporting a new plant science initiative on trees will be considered. Basic science on fundamental mechanisms of gene expression will continue to be important, particularly where it links through to the control of nutritional quality of crops, crop product quality or to potential

biotechnological application. The development of underpinning research to meet the needs of the growing biotechnological industry in Scotland is recognised as being an important growth area. Parts of existing programmes may be realigned to meet changing end-use requirements.

C.16 The Plant Science programme is relevant to several key end-use sectors. Research on the control of pests and diseases, whether it is focused on the agent itself or the search for novel forms of resistance will ultimately deliver improved, sustainable and benign methods of pest and disease control and thus is highly relevant not only to sustainable agriculture but also to the environment end-users. Research on the germplasm collections, which helps to preserve and utilise biodiversity, is relevant to environmental interests. Conventional breeding-type programmes are relevant to sustainable agriculture and environment end-users.

C.17 The existing genomics research on the development and application of marker technologies and the identification of novel Expressed Sequence Tags (EST) sequences falls under biotechnological interests as well as being classed as sustainable agriculture and may also be relevant to the environment. Other areas of research which are relevant to biotechnology are the development of plant viruses to produce high-value proteins in plants (eg the "OVERCOAT®" system), the identification of novel promoters and starch biochemistry. The plant science domain also contributes to nutrition and human health interests with research on antioxidants, free radicals and functional foods.

Animal Science

C.18 SOAEFD funds a considerable programme of research in animal science relating particularly to farmed livestock although increasingly also relevant to humans. Much of this work is recognised to be of high scientific quality and fulfils an important role as a component of the UK science base in the animal sciences. Many of the resources and expertise in the animal sciences funded by the Department are unique within the UK. Currently, there are particular strengths in studies on nutrient metabolism at the cellular level, appetite control and diet selection, cell biology, foetal and post-natal growth and development, and large animal physiology.

C.19 In the future, the maintenance of depth of focus on strategically important areas of work will be a major aim for the animal science programme. The increasing costs of research allied to reduced funding has led to contraction of the research base in some areas. There is a need to review the programme in animal sciences to identify areas which no longer have the critical mass of effort required

to produce work which is nationally or internationally competitive. These areas will require to be rationalised, refocused or developed such that, across the programme, issues of strategic importance are researched in appropriate depth.

C.20 There are a number of areas of work within the animal science programme which have been continued for many years and where the strategic relevance now needs to be reconsidered. Work, originally commissioned to address productivity within the agricultural sector, has lead to the development of considerable strengths in whole animal physiology. Most of the production related studies have already been curtailed or re-oriented to meet different or evolving end-user requirements, both within the agricultural sector and beyond. It is intended to continue this process of change and to build on the strengths in whole animal physiology and in this respect, work on lactation and reproduction, including nutritional aspects, will be reviewed.

C.21 A further strength of the animal science programme lies in the study of fundamental cellular mechanisms. Over recent years, this programme has developed such that a significant proportion of the animal science research is currently targeted at this area. The strategic objectives of the programmes on bone biology, cell physiology and gut microbial ecology will be reviewed, again in the light of end-user requirements for underpinning research and particularly with respect to nutrition and human health.

C.22 In addressing needs for fundamental understanding of primary product quality the programme on muscle biology, which is important in relation to meat product quality, will be enhanced. It is widely recognised that fundamental understanding of the processes and mechanisms operating within developing muscle tissue, which subsequently becomes meat of superior eating and processing quality, is generally lacking. In consultation with other funders including industry and commercial interests, an expanded programme in this area will be developed. The Department already funds a considerable programme of research on milk quality issues and the emphasis on end-user relevance of this work will remain paramount.

C.23 The strategy review process has identified five end-user groups to which the SOAEFD programme relates. Much of the animal science programme is important to sustainable agriculture. Animals are a major focus of agricultural systems in Scotland and animal products account for a considerable proportion of the primary outputs, particularly in the less favoured areas in the hills and uplands. Yet these animal products are valued highly for their quality attributes including the

image of 'natural' production systems. Understanding of the fundamental processes of nutrition, growth and development of food producing animals, and the effects of husbandry and management on the animals and their environment, will lead to development of systems which are not only economically efficient but are in tune with both animal welfare and environmental objectives of sustainability. Improving product quality starts with an understanding of the biological systems and stretches through husbandry and management applications to the approaches and attitudes of consumers. It is a strength of the SOAEFD programme that all these aspects can be encompassed within the programme and even, where appropriate, within a project.

C.24 An increasingly important area of the animal science programme is in its relation to human nutrition and health. Much of this work was originally aimed at understanding animal nutrition at the cellular level, however as the understanding of fundamental mechanisms controlling cellular metabolism has advanced, so the relevance to nutrition of animal cells in general has come to the fore. Simultaneously has come the acceptance of the importance of nutrition to human health and quality of life and hence the knowledge generated within the SOAEFD animal science programme has become more widely acknowledged for its relevance to human health. This change in emphasis will be built on to refocus the objectives of the studies to important questions of nutrition that may be particularly relevant to the human situation.

C.25 Work which is carried out on fundamental systems by its very nature is fairly distant from direct application but at the same time such work can lead to highly successful opportunistic identification of products and processes that have a ready market. The programme of animal science funded by SOAEFD is diverse and as such may lead to a number of end-uses in the knowledge based industries of the food and biotechnology sectors.

C.26 Animals are an integral part of rural economies and land use systems. Studies on the interactions of animals with the natural environment are an important interface between the agri-environment and animal science programmes. Studies on these aspects of animals are relevant both to the environment and natural heritage, and rural communities and development end-uses.

Animal Health and Welfare

C.27 The SOAEFD programme of research in animal health and welfare is highly regarded both nationally and internationally. There are recognised strengths in sheep immunology, immunopathology of parasitic and viral diseases, in parasitology, and in animal behaviour and welfare. The overall thrust of the programme, however, is somewhat diffuse and could be better focused and there is a clear need to establish collaborations between groups of researchers with complementary skills both from within and beyond the sponsored bodies. The role of veterinary surveillance is well recognised both within and outside Scotland and should be developed as a targeted adjunct to the research activities. The sponsored bodies have potential to provide the lead in knowledge of gene expression in farmed animals and their pathogens. However the appropriate technology (genomics, proteomics, bioinformatics) is not yet established.

C.28 In setting priorities for research in animal health and welfare, SOAEFD will be guided by policies and recommendations at international, national and local levels (eg EU, FAWC, State Veterinary Services and the future FSA). New or emerging problems in animal health identified by means of surveillance work may occasion shifts in emphasis within research programmes. SOAEFD will therefore require that a focused, skills-based research capability is in place which can respond to changing problems and priorities within animal health. In order to achieve appropriate depths of skills, projects on specific animal diseases will be reviewed and evaluated in terms of their strategic relevance to end-users and SOAEFD policy. Reductions in the breadth of activities may be required in order to prioritise development of the underpinning scientific disciplines.

C.29 SOAEFD will ensure that current strengths in ruminant immunology and pathology are maintained at a high standard and deploying state of the art technology. There will be an expectation that increased research efforts will be aimed at exploitation of information generated by genomics or proteomics research to strengthen understanding of animal health problems within discipline-based studies of host-pathogen interactions, control of pathological processes including the genetic basis of disease, and regulation of immune function. Excellence in the areas of parasitology and animal behaviour will also be supported. Where relevant to particular health problems, epidemiological studies will be supported and appropriate input from the fields of biomathematics and economics will be included. Alternatives and improvements to prolonged treatments with chemical therapeutics will be encouraged and the zoonotic potential of animal infections will continue to be an important and relevant area of research impact.

C.30 Animal health and welfare-related research will form part of a cohesive programme of research on animal biology and will be part of SOAEFD's overall strategic biological research effort. It is anticipated that relevant expertise and knowledge from related areas of the programme will be directed as necessary toward understanding and solving health/welfare problems associated with particular farming or husbandry practices.

C.31 The current sub-themes within the animal health and welfare domain are highly relevant to the areas of sustainable agriculture and to the biotechnology and food industries. These programmes are also relevant, to a lesser extent, to human health and in some cases contribute to the benefit of the environment and natural heritage (welfare and physiological stress, welfare and farming systems).

Socio-economics and Land Use

C.32 This domain has evolved as a product of the Strategy Review. This shift in emphasis reflects the widespread recognition of the need to embrace social science and economic analysis approaches to research within the Department's programme and is seen as a particular opportunity to add both value and relevance to the programme of research as it currently stands. The introduction of such approaches will complement existing scientific research capabilities and strengths within the programme and in particular will complement the agricultural economics and land use programmes. In future it is intended that research on land use and rural socio-economics will be more closely aligned to ensure that synergies between the disciplines can be maximised to satisfy the policy requirements that this area of research can fulfil.

C.33 There are also wider opportunities for the introduction of social and economics approaches to enhance the value of research throughout the animal, plant and food research programmes. The application of these approaches will be encouraged where appropriate and mechanisms will be put in place to ensure that this type of research is integrated within the programme more widely.

C.34 Research on land and its management, which includes land use monitoring, sustainable farming and ecosystem studies, although of high potential value to Scottish Office policy, lacks cohesion. Land use studies have lost focus and the sustainable farming systems and ecosystem studies in the Department's programme are a random mixture of projects with little added value being gained by projects in related areas. As a result of the Strategy Review this programme of research will be revised. Land use change research will be reviewed and more closely aligned with rural socio-economics research.

C.35 There are five end-user categories described within the Strategy Review. This area of research is of high relevance to three of these categories: environment and natural heritage; rural communities and development; and sustainable agriculture. There are particular needs to consider the social issues surrounding rural development and the effects on communities, at many levels and in many ways, of policy decisions. In some cases this impacts on sustainable agriculture or environmental concerns also. The systems which operate within rural communities are complex, and necessitate a multi-disciplinary approach to both understanding problems and developing appropriate solutions. In framing a future research strategy to increase the profile of socio-economics research in the programme there will be greater consideration given to the utility of the research to all of these end-user categories. This will include greater consultation with end-user representatives in defining the forward programme of research in this area as well as involving them more closely when the work is progressing.

D | GLOSSARY

BBSRC	Biotechnological and Biological Sciences Research Council
BioSS	Biomathematics and Statistics Scotland
CAP	Common Agricultural Policy
CHABOS	Committee of the Heads of Agricultural and Biological Organisations in Scotland
DANI	Department of Agriculture, Northern Ireland
DSS	Decision Support System
ESRC	Economic and Social Research Council
FAWC	Farm Animal Welfare Committee
FRS	Fisheries Research Services
FSA	Food Standards Agency
HEI	Higher Education Institution
HRI	Hannah Research Institute
IPR	Intellectual Property Rights
MAFF	Ministry of Agriculture, Fisheries and Food
MRI	Moredun Research Institute
MLURI	Macaulay Land Use Research Institute
NERC	Natural Environment Research Council
NCR	Non-Commissioned Research
RBGE	Royal Botanic Garden Edinburgh

ROAME	Rationale Objective Appraisal Monitoring Evaluation (research system)
RRI	Rowett Research Institute
SABRIs	Scottish Agricultural and Biological Research Institutes
SAC	Scottish Agricultural College
SASA	Scottish Agricultural Science Agency
SCRI	Scottish Crop Research Institute
SEPA	Scottish Environment Protection Agency
SHEFC	Scottish Higher Education Funding Council
SNH	Scottish Natural Heritage
SNIFFER	Scotland and Northern Ireland Forum For Environmental Research
SOAEFD	The Scottish Office Agriculture, Environment and Fisheries Department
SOEID	The Scottish Office Education and Industry Department
The Department	For the purposes of this paper synonymous with SOAEFD

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